Industry Value Chain Analysis on Benefit Models of New Energy Vehicles

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***Abstract*-Industry Value Chain Analysis offers an integrated framework to research the modelling, design, and measurement of business performance by uniquely encompassing the plan, govern and execute requirements for the design, product, and customer aspects of business. When faced with the challenge of environmental crisis and energy crisis, it is important and strategic for some countries to develop new energy vehicle. This paper analyzes the value chain format of new energy vehicle, and emphasizes that the strategies to build the benefit models are exactly value chain positioning, resource integration optimizing and consumer-oriented channels.**

Keywords-New Energy Vehicle; Industry Value Chain; Benefit Models

I. INTRODUCTION

Value chain, as a business management concept, was firstly raised by Michael Porter in his best-seller in 1985, Competitive Advantage: Creating and Sustaining Superior Performance. Value chain categorizes the generic value-added activities of an organization. The "primary activities" include inbound logistics, operations (production), outbound logistics, marketing and sales (demand), and services (maintenance). The "support activities" include administrative infrastructure management, human resource management, technology (R&D), and procurement. The cost and value drivers are identified for each value activity.

Capturing the value generated along the chain is the new approach taken by many management strategists. By exploiting the upstream and downstream information flowing along the value chain, firms may try to bypass intermediaries to create new business models, or in other ways create improvement in its value system. Enterprises have to make coordination and collaboration, invest in information technology, change organizational processes, committed leadership, flexible jobs and adaptable, capable employees and try to create a supportive organizational culture.

The impact of globalization on the auto industry in developing countries is not only reflected on changes in trade and investment policies and the globalization strategies of leading companies, but also by changes within auto industry value chains. In the modern auto industry, economy of scale is no longer to be found predominantly in assembly. However, economy of scale is still important in the areas of components production and vehicle design.

The supply of oil resource is limited, and will exhaust in the future. The price of oil is rising in recent years. At the same time, the pollution caused by automobile exhaust gas is getting more and more serious. Because of the huge demand in the market and rigorous environment situation, the new energy vehicle would be the next revolution of automobile industry. Developing new energy vehicle has become one of the important strategies for many countries' government. Major automobile companies in the world such as General Motors, Ford, Honda, Toyota, Volkswagen etc. have started up their plan to research and manufacture green cars. A lot of researches have been carried out for numerous years in order to achieve technical goals such as optimizing efficiency of the vehicle propulsion system as well as battery system, achieving longer distances per charge, rapid acceleration, high torque at low speeds etc. In spite of technical advantages and environment friendliness, new energy vehicles have not yet successfully commercialized since it requires confluence of technology, market, economic and political factors which could transform green cars into an attractive choice for consumers.

II. THE FORMAT OF NEW ENERGY AUTOMOBILE INDUSTRY VALUE CHAIN

New Energy Vehicles mainly include Hybrid Vehicle (HEV), Electric Vehicle(BEV), Fuel Cell Vehicle(FCV), Hydrogen Synergy Drive and other new energy (such as high effective power accumulator, dimethylether) vehicle. Because the HEV, BEV, FCV all belongs to Electric Vehicle (EV), EV becomes the main body of new energy vehicle. New energy vehicle industry chain is made up of some core content such as technology research, product design, product manufacturing, marketing, management, talents, and capital etc. With great effort, China has made some progress on new energy vehicle research and industry ability, and has formed market of considerable size. China has formed the "Three Vertical" and "Three Horizontal" research layout and technology system. The "Three Vertical" refers to HEV, BEV, and FCV. The "Three Horizontal" refers to Multi-energy Drive Integrate Control System, Electromotor and its Control System, Battery and its Management System. Nevertheless, some core technologies need further breakthrough. And the industrialization and commercialization in China still face some challenges such as product cost and social supporting system, etc.

A. Technology Research

The country will acquire the power in new energy vehicle industry if it would hold the core technology resources at the beginning. Since 2001, China has started the "863Plan" Electric Vehicle primary Special Project, and has gradually built the "Three Vertical" and "Three Horizontal" research layout. During the year 2006 and 2007, China produced HEV, BEV, and FCV with its indigenous design. With China government's organizing and promoting, some strategic alliances have been established together with research institutes, universities, and enterprises, to focus on the research of core technology and core component of new energy vehicles.

The United States faces major challenges in meeting the ever-increasing demand for transportation goods and services while striving to minimize adverse energy, environmental, and economic impacts. It is imperative to produce more efficient

vehicles in order to meet these challenges. Barack Obama insisted that he had led efforts to jump start federal investment in advanced vehicles, including combined plug - in hybrid/flexible fuel vehicles, which can get over 150 miles per gallon of gas, and he will continue this leadership by investing in advanced vehicle technology with a specific focus on R&D in advanced battery technology[1].In USA, the Argonne National Laboratory (ANL) is a U.S. Department of Energy Office of Vehicle Technologies national laboratory that simulates, validates, and evaluates plug-in hybrid electric vehicles. Electric Power Research Institute (EPRI) research attempts to quantify the effect of adopting plug-in vehicles on greenhouse gas emissions and on the power grid. Idaho National Laboratory (INL) supports the U.S. Department of Energy Advanced Vehicle Testing Activity. The researchers in National Renewable Energy Laboratory (NREL) are investigating battery thermal management, improved power electronics, and market analysis. Oak Ridge National Laboratory (ORNL) finds ways to reduce cost and weight, and increase safety and reliability of next-generation hybrid, battery-powered, and fuel cell vehicles. Pacific Gas and Electric Company is researching and developing battery electric, hybrid electric, fuel cell vehicles. The Electricity Infrastructure Operations Center of Pacific Northwest National Laboratory (PNNL) focuses on plug-in hybrid electric vehicle integration and smart-charging research, analysis, and demonstration. The Advanced Battery Research, Engineering, and Evaluation Facility of Sandia National Laboratories (SNL) researches, engineers, and tests advanced battery technologies for electric-drive vehicles [2]

B. Product Design

Product design is the initial phase that turns the new energy vehicle from ideas into visual model. The quality of product design would affect the acceptability of customers. In China, some self-owned brands such as First Automotive Works (FAW), Changan， Huachen， Changcheng， Jili， Qirui， Zhongtai，Jinlong，Jinlv，Futian，Jianghuai have completed the whole-vehicle design. 2010 Ford Fusion Hybird is capable of running up to 47 mph solely on electric power, and is winner of the prestigious Motor Trend Car of the Year award in 2010. Some experts say it is fantastic to drive hybrid. 2010 Honda Insight is one of the affordable hybrid car that is available, and has a decent amount of Zip. Its transitions among gas power, electric power and gasoline-electric are super smooth. 2010 Toyota Prius is the benchmark for green car, and is in its third generation. The new version is bigger and more powerful. It is capable of electric-only mode at low speeds (up to about 25 mph) and highway coasting.[3] Many automobile companies consider that the new energy vehicles are the new profit making fields, so they try to design the powerful, more comfortable, and prettier cars. The design of new green cars tries to attract customers on price, safety, and reliability.

C. Product Manufacture

The Battery is the most expensive component in an electric vehicle. Around 80% of the cost of a PHEV-40's drive system is due to the battery pack. Other components include the electric motor, inverter, power control unit, and generator. In China, for Hybrid Vehicles (HEV), the core components integrate ability, engine system optimization, technology matching need to improve. The reliability and endurance of some parts such as battery, engine, fuel cell need further improvement. [3]

Through the Recovery Act, the United States made an unprecedented investment to build electric vehicle (EV) domestic manufacturing capacity in order to secure American's position as a global leader in advanced lithium-ion battery technology. This investment includes $2.4 billion in loans to three of the world's first electric vehicle factories in Tennessee, Delaware, and California, and $2 billion in grants to support 30 factories that produce batteries, motors, and other EV components. Companies are matching the funding dollar for dollar, doubling the impact of taxpayer investments. These grants enable companies to build the capacity to produce 50,000 EV batteries annually by the end of 2011 and 500,000 EV batteries annually by December 2014[4].

Three significant changes have taken place in automotive industries. Firstly, there was a shift in design activities from assemblers to suppliers, together with increasing dialogue on design between the two parties. Secondly, there was a shift towards the supply of complete functions (systems, sub-assemblies, or modules) to individual components. Thirdly, the assemblers became more involved in the specification of the production and quality systems of their suppliers. The suppliers, who had previously provided ready-designed parts (for example, batteries) for many different companies in the period of mass production, moved towards greater customization, tailoring their products to the needs of specific companies. Similarly, many of the subcontracting companies that had formerly involved in the assemblers' designs moved towards offering their own design solutions. In both cases, the assembler provides the overall performance specifications and information about the interface with the rest of the cars and the supplier then designs a solution using its own technology. New energy vehicles manufacture will keep such trend. The data about Onroad Alternative Fuel Vehicles (AFVs) Made Available by Year are shown in Fig. 1. [5].

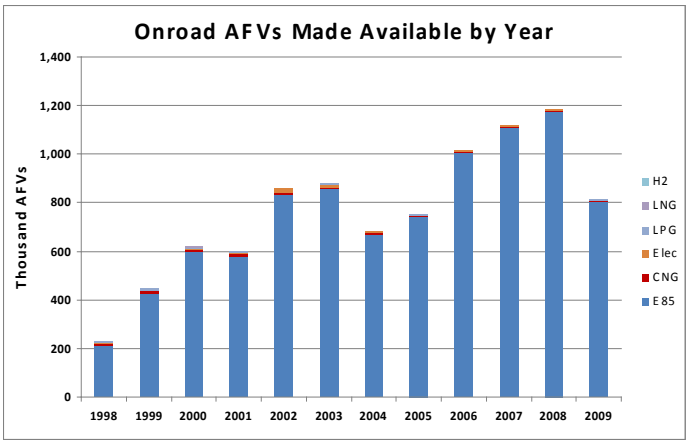

Fig. 1 Onroad alternative fuel vehicles (AFVs) made available by year

There's a big shift going on between the internal combustion engine and the electric engine. There are implications for that across the value chain – the most obvious of which is the need for electricity rather than gasoline. Even more significantly, new technology is capturing large sections of the value chain, driven especially by the battery and power-train. Basically, the traditional power-train is being substituted with electric batteries, power electronics, and electric motors.

The whole electric vehicle (EV) and propulsion industry is converging. It's not just about the automotive sector anymore. It's about the entire ecosystem, which spans completely different players including smart grid providers, electronics

providers, battery providers, government agencies, fleets, etc. These players all need to work together and engage in decisions to create a seamless, consumer-friendly ecosystem. But this is a mammoth task.

D. Marketing Action

The survival of an industry depends on capabilities of transferring the core resource into market value. This transfer should realize by marketing action. The enterprises deliver the usage value to customers, and realize value innovation. If there is no market, no matter how good product is, there is no real industry. The marketing action composes as the important link for new energy vehicle industry chain.

Conventional hybrid electric vehicles (HEVs) have been on sale in the U.S. for over ten years. And today sales have grown almost three percent of total light-duty vehicles. Over 1.6 million HEVs have been sold over the past six years. To reach the one million vehicle goal, EVs will need to average just under 1.7 percent of sales through 2015 (assuming sales of 12 million light-duty vehicles per year)[4]. Electric vehicles offer a clean and green alternative to petrol and diesel-powered transport. There are currently 1,700 electric vehicles being used in London. The Mayor of London wants to increase this to 100,000 (or five per cent of the capital's fleet) by making it easier to charge them.

EVs have a shorter range than comparable petrol/diesel vehicles. The lack of charging infrastructure is a major barrier to the MORE WIDELY use of EVs. The price of new energy vehicles is still expensive and the consumption notion of energy-saving hasn't gained ground. Lacking the confidence in the technology of new energy vehicle and worrying about the convenience of maintaining and repairing repair also hinder consumers from buying green cars.

In order to develop new energy vehicles, China has implemented the Ten Cities, Thousand Vehicles Program which has significant enhancement of coordination across the industry value chain. The country is beginning to develop new businesses and business models to provide the infrastructure, component, vehicle, and service facilities to enable an EV ecosystem. In order to deliver electric vehicles to the market in China, new vehicle value chains have emerged to narrow the technology and manufacturing gaps that the existing automotive value chain has for EVs in China. One example of such an emerging value chain is being developed by China's fifth largest automaker, Beijing Automotive Industry Holding Corporation (BAIC). To drive up the development of electric vehicle technology, BAIC has created a separate company, Beijing New Energy Vehicle Company, to focus solely on electric vehicles. This company, which has plans to build 150,000 EVs and HEVs by 2015, has established relationships with global companies and is developing new local companies to enable these plans. For example, the companies' announced acquisition of vehicle platform designs from Saab is now served as the basis for its mid- and high-level EVs. Beijing New Energy Vehicle Company is developing the control and electric drive systems and has formed a separate company, Beijing Pride Power System Technology Co., for the development of battery systems. Beijing Pride Power System Technology Co. is responsible for developing the integrated battery systems, including the full pack and battery management system. According to statistics released by China Association of Automobile Manufacturers (CAAM) the Chinese market saw sales of 8,159 vehicles whilst production was slightly higher at 8,368 units in2011.

E. Global New Energy Vehicle Industry Value Chain

With increasing prices of gasoline, electric vehicles are hitting the mainstream. Major car makers, such as Daimler AG, Toyota Motor Corp., General Motors Corp., Renault SA, Peugeot-Citroen, VW, Nissan and Mitsubishi Corp., are developing new-generation electric vehicles. Hybrid Electric Vehicle (HEV) Sales by Main Model is as followers Table I[5].The whole industry chain includes the upstream resource such as lithium, nickel and thulium, while the downstream infrastructure system includes charging station, and the core parts such as battery, driver and control system, and entire vehicles (passenger car and bus). On the one hand, Chinese automobile enterprises need to infiltrate into the whole global new energy vehicle industry chain to reduce the research and development risk, to control the financial risk of building international marketing networks, to acquire underlying and complex knowledge resource. On the other side, Chinese new energy vehicles enterprises have to foster independent innovation abilities in order to obtain long-term development.

TABLE I
HYBRID ELECTRIC VEHICLE (HEV) SALES BY MAIN MODEL

Hybrid Electric Vehicle (HEV) Sales by Main Model					
Vehicle	**2006**	**2007**	**2008**	**2009**	**2010**
Toyota Prius	106,971	181,221	158,574	139,682	140,928
Honda Civic	31,251	32,575	31,297	15,119	7,336
Ford Escape	20,149	21,386	17,173	14,787	11,182
Lexus RX400h	20,161	17,291	15,200	14,464	15,119
Toyota Highlander	31,485	22,052	19,441	11,086	7,456
Mercury Mariner	3,174	3,722	2,329	1,693	890
Toyota Camry	31,341	54,477	46,272	22,887	14,587
Nissan Altima		8,388	8,819	9,357	6,710

Experts predict that in 2012, Hybrid (IC/electric) will capture about 8% of the new car market globally. Another 5% will be electric cars and mini-cars. From 2012 to 2015, Hydrogen fueled cars will become more attractive and will start to be increasingly cost competitive with ICE and hybrid cars. From 2015 to 2020, a significant proportion of road vehicles will use hydrogen as the principal fuel in both of internal combustion engine and of gas turbine-propelled vehicles18 as well as fuel all-electric vehicles.

In spite of the above technical advantages and environmental friendliness of the electric vehicles, they are not yet successfully commercialized. Factors which affected successful commercialization of electric vehicles include weight and volume of batteries, high initial cost as well as high battery maintenance cost, safety and considerations of batteries, less driving range and lack of proper infrastructure to support battery charging. It requires the confluence of technology, market, economic and political factors that could transform electric vehicles into an attractive choice for consumers. [6]

III. BUILDING NEW ENERGY VEHICLE INDUSTRY BENEFIT MODELS

Though the development of new energy vehicle is a wise choice for human when faced with the condition that oil resource will be exhausted and environment crisis is serious, pursuing profit is still the goal for enterprises. Pursuing profit is also the requirement for the industry's survival. The benefit mode for new energy vehicle industry should be built with the following aspects.

A. Enhance the Construction of Relative Facility and Infrastructure

In parallel with the development of the vehicle and component value chain elements, it is essential that a new value chain be built for the development, deployment, and operation of the vehicle recharging infrastructure. Such a value chain requires involvement of many stakeholders. First, the utility is required to ensure that the introduction of new electrical loads on the grid does not create disruptions. Second, smart grid technology providers need to be involved in the development and production of the new recharging equipment and network backbone. Additionally, the original equipment manufacturers (OEMs) and battery management systems suppliers need to manage the trade between the infrastructure and vehicle battery system to optimize the battery charging system. An example is the Beijing bus battery exchange stations, which included multiple value chain stakeholders. A bus operator, Beijing Public Transport, was involved in determining the new operating modes for the EV buses.

B. Promote New Service Models

In addition to the vehicle and infrastructure, new service business models will emerge in the value chain. The Beijing bus pilot also serves as an example of such new service models. Due to the significant upfront cost of the batteries for buses, a leasing model was deployed by the battery manufacturer, CITIC Guoan MGL Battery Co, in conjunction with the bus operator, Beijing Bus Group. The batteries are leased from CITIC Guoan MGL Battery Co, based on the distance driven. In addition to the battery supplier and the bus operator, this model also requires the involvement of other value chain stakeholders. For example, since the battery management and recharging systems are critical determinants of how the battery will age over time, collaboration with the technology provider, Beijing Technology University, was required to determine how the battery would age and the likely rate of depreciation.

C. Exact Value Chain Positioning

The different sections of the new energy vehicle industry value chain are discrepant on the strategy importance, profit distributing, and the resource availability. The enterprises should consider the discrepancy of different value sections, and learn the rules of industry value transfer. The enterprises should position its measurable and profitable point on the industry value chain according to its own resource, ability, and advantage. Chinese new energy vehicle industry should hold the core of research technology, should insist on independent research innovation. Because only with the core ability, it is possible to develop whole value chain, and obtain the durative benefit and long-term development.

D. Optimizing Resource Integration

In order to develop Chinese new energy vehicles, the power is limited for single enterprise or single research institute. Besides government's investment and policy support, the Chinese enterprises should optimize resource integration. Chinese enterprises could set up new energy vehicles group companies, obtain the manufacture advantage, focus on the capital with reasonable arrangement, and avoid the internal conflict. It is also necessary for China to integrate the technology research power, to form powerful join force, to take part in the international competition. At the same time, Chinese enterprises should infiltrate into global new energy vehicle industry value chain actively. With some strategy modes such as strategy alliance, incorporation, outsourcing of non-core business, merging and acquisition, etc, Chinese enterprises try to reduce research costs and product risk, to learn the advanced knowledge and to accumulate technology ability. [7]

E. Consumer-Oriented Benefit Modes

The EV industry value chain that is developing is likely to be greater than US$ 250 billion worldwide by 2020. The utilities will play a major role in this new value chain as the suppliers of the power required. Though they are the primary contenders for a role in the infrastructure business that delivers the power to the vehicles, it is not clear if they will be the only ones doing so or if they will be providers of the services whose revenues can help setting the cost of the infrastructure (e.g., driver services, charging station operation and maintenance and so forth). The independent, third-party players (like Project Better Place) could take a role in providing electricity and services, as in the case of the United States and Europe.

How to realize the commercialization for new energy vehicle is the common problem for the world automobile industry. To reach the commercialization for new energy vehicle, the enterprises need to build the consumer-oriented benefit modes. It is necessary for enterprises to learn the consumers demand preference, to understand consumers' considerations on the cost, reliability, motivation, visualization, security and convenience of new energy vehicle. The enterprises should do their best to satisfy consumers' requirement with whole aspects. It is important for Chinese enterprises to foster independence brands. The excellent brands are important invisible assets and magic weapon in market competition for new energy vehicle industries. Once obtaining consumers' confidence and loyalty, the brands would have powerful force to profit. In the course of commercialization for new energy vehicle, the government's policy supporting is very important. Government should release some favorable policies to stimulate consumer purchasing. At the same time, government should improve the building of supporting infrastructure. Even without government's help, as technology matures and manufactures ramp up production, the gap in up-front costs between hybrids and traditional gas-powered cars is likely to be narrowed. As government incentives are added to the mix, this convergence is likely to come sooner, rather than later. [8]

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